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Fertilization Practices for Double Cropping Systems

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Double cropping has become an important practice in the state of Kentucky. While the wheat-soybean grain intensive production system is the most widely used on an acreage basis (approx. 3/4 million acres per year) several other systems are being adopted by Kentucky growers. Most of these involve some silage production for beef and/or dairy cattle. The fall seeded small grain (wheat, barley, triticale) is harvested at an immature stage of growth and ensiled and a subsequent crop for silage (corn, grain sorghum) or grain (soybean, grain sorghum) is planted. The use of reduced and no-tillage management will speed up planting and minimize surface soil moisture loss as the second crop starts growth. As two crops are to be grown on the same field in a single season, fertilization management is of importance to double crop producers.

Fertilization and Double Cropping for Silage

Fertilization in double crop systems involves proper timing. Nitrogen fertilizer should be applied to each crop in succession according to current recommendations (AGR-1: Lime and Fertilizer Recommendations). From a practical standpoint, it is convenient to apply all phosphorus and potassium in the fall for both crops in the double crop system. However, when the small grain is to be harvested for silage, UK Agronomy research indicates that the potassium requirement of the second crop may not be efficiently met if all the potash is applied in the fall (Table 1).

Table 1. Effect of fertilization rate and liming on the average annual silage yield and potassium removal, and final soil test potassium on a Pope silt loam.

Annual Fertilization N-P_2O_5-K_2O	K Application Method	Annual Silage Yield: Small Grain	Annual Silage Yield: Corn	Annual Silage Yield: Total	Crop K_2O Removal: Small Grain	Crop K_2O Removal: Corn	Crop K_2O Removal: Total	Soil[+] Test K
--lbs/acre--		tons/A @65% moisture			-----------lbs/acre------			
250-180-250	all fall	6.9	18.4	25.3	140	150	290	300
250-180-250	split	6.8	17.7	24.5	150	170	320	350
150-110-150	all fall	5.7	13.3	19.0	110	100	210	230
150-110-150	split	5.8	17.7	23.5	110	140	250	270

[+] Final soil test after 4 years of cropping

Corn silage yield dropped an average of 28% when the lower rate of potash was all applied in the fall. Delaying half the potash until just prior to corn planting returned corn silage yields to high levels. Use of higher rates of potassium fertilizer in the fall maintained high silage yields and "substituted" for the second application required to maximize K utilization efficiency at the lower total application rate. The use of small grain as silage resulted in the removal of large quantities of potash; quantities almost as large as that removed in corn silage. This is because the small grain silage potassium concentration was 2.5 times higher than that found for the corn silage. Total crop potash removal exceeded applied fertilizer potash in all cases. Where the lowest rate of fertilizer was applied all in the fall a large decline from the initial soil test potassium value (300 K) was observed after four years of cropping. As small grain potassium removal was unaffected by the fertilizer timing, "luxury consumption" of potash by the small grain crop was not the cause of the reduced corn silage yields observed. Rather, losses from the soil's plant available potassium fraction, whether by leaching or fixation, occurred over winter and during the small grain growth period.

If the small grain is to be harvested for silage, apply phosphorus and potash according to soil test recommendations for small grains in the fall. Additional potash should be applied prior to seeding the second crop (see Table 2).

Table 2. Potash recommendations for the second crop following small grain silage.

	lbs K_2O/acre to apply			
Soil test levels	Soybeans	Grain Sorghum	Corn-Grain	Corn-Silage
High (above 250 K)	0	0	0	60
Medium (250-165 K)	0-60	0-60	0-60	60-120
Low (below 165 K)	60-120	60-120	60-120	120-180
Very Low (below 75 K)	120-150	——	——	——

Because of the increase in potash removal in corn silage production systems it is recommended that the potash fertilization rate prior to corn planting be increased by 60 lb K_2O/A over the rate recommended for corn grain production for fields devoted to either continuous corn silage production, or for corn following small grain silage production.

Fertilization and Double Cropping For Grain

Double cropping is associated with "intensive" production and producers are often concerned about depleting soil reserves of plant available phosphorus and potash. Recent research was conducted on a continuous wheat-soybean double cropping (4 grain crops every two years) system at Lexington to provide answers to this and other questions. Crop response and soil fertility data for a two year period involving four grain harvests are presented in Tables 3 and 4. Soil samples were taken after the harvest of each crop. Small quantities of fertilizer were added to certain treatments every fall just prior to wheat seeding in order to maintain the basic difference in soil test levels found in these plots after 20 years of differential fertilization. After at least one-month of soil-fertilizer reaction time, all plots were resampled in mid-December. Such samples were taken prior to any substantial wheat growth, and are the "initial" test levels described in the second column of data in Tables 3 and 4. These initial soil test levels and their changes with continued cropping are the focus of the following discussion.

Potassium---Although both wheat and soybean yields increased when soil test potassium was raised from low to medium test levels (Table 3), the relative increase was greater for soybeans than wheat (17% vs 10%). Little additional soybean yield was found at higher soil test potassium levels despite a decline in the available soil potassium from 240 to 190 K, which is still considered a "medium" soil test.

Table 3. Wheat-soybean double crop grain yields and nutrient removal in relation to soil test potassium on a Maury silt loam (2 year average).

Fall Fert. K_2O Applied	Soil* Test K Initial	Wheat Yield	Wheat K_2O Removal	Soil† Test K Between	Soybean Yield	Soybean K_2O Removal	Soil§ Test K After
lb/A		bu/A	lb/A		bu/A	lb/A	
0	160	58	15	150	29	31	140
60	240	64	16	190	34	37	170
30	420	63	17	380	35	40	360

*Soil test prior to spring growth of wheat but about one month after fall fertilization.

†Soil test taken after wheat harvest, just prior to soybean planting.

§Soil test after bean harvest, and prior to any fall fertilization.

Phosphorus---Wheat yields responded positively to an improvement in phosphorus nutrition (Table 4). This yield increase was surprising because the lowest soil test phosphorus level is rated as "medium-high". The main reason for that response was the lateness of wheat planting, which averaged around November 7 in this continuous double crop system. In contrast, there was no soybean yield increase over the three soil test P levels tested.

Table 4. Wheat-soybean double crop grain yields and nutrient removal in relation to soil test phosphorus on a Maury silt loam (2 year average).

Fall Fert. P_2O_5 Applied	Soil* Test P Initial	Wheat Yield	Wheat P_2O_5 Removal	Soil† Test P Between	Soybean Yield	Soybean P_2O_5 Removal	Soil§ Test P After
lb/A		lb/A	lb/A		bu/A	lb/A	
0	60	58	20	65	33	24	60
60	100	64	30	85	32	25	80
0	200	62	30	190	32	25	180

*Soil test prior to spring growth of wheat but about one month after fall fertilization.

†Soil test taken after wheat harvest, just prior to soybean planting.

§Soil test after bean harvest, and prior to any fall fertilization.

These data indicate that wheat, a winter annual, was more sensitive to phosphorus nutrition, whereas soybeans, a summer annual, are responding more to potassium. This differential crop response pattern has been demonstrated in past single crop research and UK Agronomy single crop fertilizer recommendations reflect this fact (Table 5). This suggests that the most efficient and economical way to manage fertilizer in the wheat/soybean double crop system is to apply phosphorus according to small grains recommendations and potassium according to soybean recommendations. While research on double crop grain sorghum has not been done, this crop has a potassium response/requirement pattern similar to that found for soybeans and an equivalent response in terms of fertilizer rate and timing would be expected.

These data suggest that it is not appropriate to add together the two single crop fertilizer rate recommendations for either P or K to get one double crop recommendation. Phosphorus application rates that reflect the greater wheat response to P and potassium fertilization rates that take into account the larger soybean response to K are sufficient (Table 5.). As small grain nutrient removal is lower in this grain intensive system, all P and K fertilizer may be applied in the fall prior to seeding the small grain.

Table 5. Phosphorus and potassium fertilizer recommendations for small grains, full season soybeans, and double cropped small grains (for grain)-soybeans.

Soil Test Levels	Single Crop Small Grain P_2O_5	Single Crop Small Grain K_2O	Single Crop Soybeans P_2O_5	Single Crop Soybeans K_2O	Double Crop Small Grain and Soybeans+ P_2O_5	Double Crop Small Grain and Soybeans+ K_2O
	---lbs/acre to apply---					
High (above 60 P, 250 K)	0	0	0	0	0	0
Medium (60-30 P, 250-165 K)	0-80	0-40	0-40	0-60	0-80	0-60
Low (below 30 P, 165 K)	80-120	40-80	40-80	60-120	80-120	60-120
Very Low (below 10 P, 75 K)	----	----	80-100	120-150	-----	120-150

+ All applied in the fall.

Final Notes

Lime management is important, particularly where large amounts of ammoniacal nitrogen fertilizer are being used. Soil pH should be maintained at or above 6. Soil samples should be carefully taken every two years in fields where a double cropping system is being used in order to ensure maintenance of soil fertility at the medium to high level where potential yield losses due to inadequate nutrition are minimal and to prevent uneconomical fertilizer usage.

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